Bay Area Air Quality Management District

939 Ellis Street

San Francisco, CA 94109

Staff Report

Proposed

Regulation 9, Rule 14:

PETROLEUM COKE CALCINING OPERATIONS

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STAFF REPORT
Regulation 9, Rule 14: Petroleum Coke Calcining Operations

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I. EXECUTIVE SUMMARY

This staff report summarizes information regarding a proposed new Bay Area Air Quality Management District (BAAQMD or Air District) Regulation 9, Rule 14: *Petroleum Coke Calcining Operations*, which is intended to limit emissions of sulfur dioxide (SO_2) from the calcining of petroleum coke. Sometimes referred to as “green coke”, this product is a black solid residual from various petroleum refining processes. In a calcining operation, green coke is sent through a heated rotary kiln to drive off contaminants in order to produce a purer form of carbon. Green coke tends to contain sulfur in addition to other contaminants. As the heat in the calcining process drives off contaminants from the coke, gaseous emissions are produced including SO_2. When the Phillips 66 petroleum coke calcining plant, commonly referred to as the “Carbon Plant”, calcines green coke under normal conditions, meaning fully operational conditions, the total sulfur dioxide emissions are approximately 4.0 tons per day (TPD).[1] The purpose of this new proposed rule is to reduce SO_2 emissions which in turn would reduce the formation of particulate matter.

Proposed Regulation 9, Rule 14 would apply generally to petroleum coke calcining plants; however, the Carbon Plant is the only such facility in the Bay Area. It is one of only two petroleum coke calcining facilities in the state and is the largest SO_2 emitter in the BAAQMD. Sulfur dioxide emissions are a public and environmental health concern and also contribute to particulate matter ($PM_{2.5}$) formation, a secondary pollutant, in the atmosphere. The proposed rule’s emission standard is consistent with the only other current SO_2 emissions standard for an operational petroleum coke calcining facility in California.[2]

The Air District committed to examining potential reduction of sulfur dioxide emissions from petroleum coke calcining operations in Control Measure SSM-8 of the Air District’s Bay Area 2010 Clean Air Plan, which sets forth a plan to achieve the California particulate matter standards as well as other air quality objectives.[3]

Staff estimates that proposed Regulation 9, Rule 14 would reduce SO_2 emissions by 1.9 tons per day (tpd) when the rule is fully implemented. The proposed rule would be completely implemented by January 1, 2020. It would require the Carbon Plant to perform an in-depth study to determine how to improve their SO_2 emissions to achieve an 80 percent control of SO_2. Once the rule takes full effect, the plant will have to either meet the 80 percent control target or meet an emissions limit of 770 tons per year (tpy) of SO_2. The Carbon Plant will also have to meet a short-term limit of 144 pounds per hour (lb/hr) of SO_2.

Staff has determined that it would be cost effective for the Carbon Plant to achieve an 80 percent control of SO_2 emissions on an annual basis. The costs to control SO_2 emissions to this level would be approximately $3,100 per ton. This is consistent with other Air District regulatory requirements.

While the 80 percent goal is cost effective, the socio-economic analysis by an Air District consultant has determined that requiring that level of control may lead to significant economic including the possible or loss of jobs.[4] In order to ensure that the controls are economically feasible, the Air District is proposing a 770 tpy limit. This corresponds to a 70% control of SO_2 and would reduce compliance costs from an estimated $3 million/year to $2 million/year. This annual emissions limit would provide the facility the flexibility to achieve the targeted SO_2 emission reductions while retaining the ability to respond to changes in market demand for calcined coke through changes in production rates.

As required by the California Environmental Quality Act (CEQA), the Air District has prepared an initial study to analyze potential environmental impacts of the proposed rule. The initial study concludes that there would be no significant adverse impacts associated with adoption of the rule.

II. BACKGROUND

A. Introduction

As stated earlier, petroleum coke calcining operations in the Bay Area occur at only at the Carbon Plant. It is one of two such facilities in California. The other facility is in Southern California. The Carbon Plant processes green coke from the Phillips 66 San Francisco Refinery to purify it and sell it to industry that is primarily offshore. The facility commenced calcining operations with a single kiln in 1960. A second kiln was added to the facility in 1968.

The Carbon Plant sells the majority of its calcined coke to a single company that uses the refined coke to produce titanium dioxide – a photocatalyst that is commonly used to manufacture white pigments that are incorporated into a wide range of applications including skincare, plastics, food coloring as well as paint and coating products.[5] A photocatalyst is a material that alters the rate of a chemical reaction when exposed to light.[6]

B. Petroleum Coke Calcining Operations Overview

<u>Petroleum Coke</u>

Petroleum coke is a carbon by-product that remains from petroleum refining processes. It is a black solid residue that results from the thermal processing of petroleum derived from feedstocks, tar, pitch, or vacuum tower bottom blends that have been cracked or otherwise processed in cokers to remove low boiling fractions. Coke consists mainly of carbon (90 - 95 percent) and is created by heat-treating the residual oil (more accurately described as tar) to a temperature high enough to polymerize it to form a non-melting solid carbonaceous material.

Coke is used as a feedstock in coke ovens for the steel industry, for heating purposes, for electrode manufacturing, and for the production of chemicals. The two most common types of coke are "green coke" and "calcined coke." Coke, as it is removed from the petroleum coking process, is referred to as "green coke." Green petroleum coke may contain approximately 15 to 20 percent residual hydrocarbon materials. Such hydrocarbons are compounds that do not polymerize in the coke cracking process and cannot be removed from the coke substrate due to process limitations. Thus, green coke is calcined to remove hydrocarbons and other impurities to make it a marketable product.

Calcining Process

Calcined petroleum coke is manufactured by heating green coke in a rotary kiln to a temperature that ranges between approximately 2200 - 2500 degrees Fahrenheit. This roasting process combusts virtually all of the residual hydrocarbons and also removes moisture from the coke. The coke's crystalline structure is refined and thus enhances the coke's physical properties such as electrical conductivity, real density (an indicator of calcined coke porosity), and oxidation characteristics. The final calcined product contains only a trace of volatile matter and sulfur content ranging from 0.3 to 6 percent depending on the original product used to generate the coke. Figure 1 is an image of calcined petroleum coke.

Figure 1: Calcined Petroleum Coke

Image Source: Carbon Plant

A rotary kiln is a long, refractory lined cylindrical device that rotates on its own axis and drives off contaminants from the green coke by bringing the contaminants into direct contact with heated gas. As the petroleum coke slides down the rotating kiln it flows counter-current to the rising hot combustion gas produced by burning natural gas. Figure 2 is an image of a coke calcining kiln at the Carbon Plant.

Figure 2: Calcining Kiln

Image Source: Carbon Plant

Sulfur Dioxide

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide gases (SO_X). Sulfur is prevalent in green coke as well as raw materials such as crude oil, coal and metal ores. SO_X gases are formed when fuels containing sulfur, such as coal and oil are burned. SO_2 dissolves in water vapor to form acid and interacts with other gases and particles in the air to form sulfate particles and other compounds that can be harmful to people and the environment. Sulfur dioxide and the pollutants formed from SO_2 can be transported over long distances and deposited far from the point of origin, thus, air quality impacts of SO_2 are not confined to areas where it is emitted. The sulfur emissions also contribute to ambient $PM_{2.5}$ pollution through the formation of sulfate particles. In addition to SO_X emissions, other pollutants are emitted from the Carbon Plant's calcining operation, including nitrogen oxides and fine particulate matter.

Scientific evidence links short-term exposures to SO_2 with various respiratory problems as well as the exacerbation of existing cardiovascular disease.[7] Emissions that lead to increased ambient SO_2 concentrations generally lead to the formation of other SO_X gases; thus, the control of SO_2 can be expected to reduce exposure to all SO_X gases. This has the co-benefit of reducing the formation of sulfate particles which pose significant health threats. The fine particles that are formed from sulfur dioxide can penetrate deeply into the lungs and worsen respiratory diseases such as emphysema and bronchitis. The fine particles can also worsen existing heart disease.

C. Controlling Petroleum Coke Calcining SO_2 Emissions

The gaseous emissions generated from coke calcining operations are typically minimized using one of three types of scrubbing control systems: wet scrubbers, semi-dry scrubbers or dry scrubbers. A dry scrubber, also called dry sorbent injection, is the technology currently used at the Carbon Plan. Wet and semi-dry scrubbing systems can better handle acid gas waste streams with higher concentrations and higher volumes than dry scrubbing systems while achieving greater emission reductions; however, they cost considerably more to purchase, install, and operate than dry scrubbing systems.

<u>Wet Scrubbing Systems</u>

Wet scrubbing systems are designed to capture either particulate matter or gaseous pollutants. Wet scrubbers that collect gaseous pollutants are commonly referred to as *absorbers*. In such a system, flue gas is ducted from the combustion source to an absorber vessel that injects an aqueous slurry of sorbent material into an acid-gas stream. Lime and limestone are examples of alkaline sorbents used to remove SO_2 from acid-gas streams in a wet-scrubbing process. (An alkaline material is a substance that has a pH greater than 7 and is capable of neutralizing an acid.) To provide optimal contact between the waste gas and the sorbent, the injection nozzles and their locations within the scrubber are designed to optimize the size and density of slurry droplets formed by the system. Optimal gas-to-liquid contact is essential to obtain high removal efficiencies in absorbers. During the reaction between the SO_2 and the sorbent material, a portion of the water in the slurry is evaporated and the waste gas stream becomes saturated with water vapor. Sulfur dioxide dissolves into the slurry droplets where it reacts with the alkaline particulates. The slurry falls to the bottom of the absorber where it is collected. Treated flue gas passes through a mist eliminator before exiting the absorber which removes any entrained slurry droplets. The absorber effluent is sent to a reaction tank where the SO_2-alkali reaction is completed thus forming a neutral salt. In a regenerative type of wet scrubbing system, regenerated slurry is recycled back to the absorber. Otherwise, the spent slurry is disposed of or can be used as a by-product. Sulfur dioxide control efficiencies for wet scrubbers range from 90 to 98 percent.[8]

<u>Semi-Dry Scrubbing Systems</u>

Semi-Dry scrubbing systems (sometimes called spray dryers) are similar to wet scrubbing systems except that the flue gas stream is not saturated with moisture. The flue gas is introduced into an absorbing vessel (dryer) where the gas is contacted with a finely atomized alkaline slurry that is usually a calcium-based sorbent. The acid gas in the stream is absorbed and neutralized by the slurry droplets. The reaction forms solid salts that are removed by a particulate control device. The heat of the flue gas is used to evaporate the water droplets thus leaving a filtered flue gas to exit the absorbing vessel. Semi-dry scrubbing systems usually can achieve control efficiencies ranging from 80 to 90 percent.[9]

Dry Scrubbing Systems

Another technology type for reducing SO_2 emissions from combustion sources that does not generate any liquid side-streams is a dry scrubbing system. In this process, the flue gas containing SO_2 is contacted with an alkaline material to produce a dry waste product for disposal. There are three common approaches to dry scrubbing:

- Injection of an alkaline slurry in a spray dryer with collection of dry particles in a baghouse or electrostatic precipitator (ESP);
- Dry injection of an alkaline material into the flue-gas stream with collection of dry particles in a baghouse; or,
- Addition of alkaline material to the fuel prior to or during combustion.

Dry sorbent injection (DSI) is the particular type of dry scrubbing technology currently in use at the Carbon Plant. The facility injects sodium bicarbonate sorbent material into the flue acid-gas stream after exiting a heat recovery system. The SO_2/sodium bicarbonate mixture is then filtered from the acid-gas stream via a control device called a fabric filter or baghouse. Although the Carbon Plant's SO_2 controls currently reduce emissions less than 50 percent on average, a fully optimized dry sorbent injection system may achieve control efficiencies ranging from 60 to 90 percent.[10]

Baghouse Operation

As mentioned above, baghouses are a key component of dry scrubbing systems. A baghouse is an air pollution control device that removes particulates from an air or gas stream emitted from commercial processes or from combustion sources. Power plants, steel mills, pharmaceutical producers, food manufacturers, chemical producers and other industrial sectors often use baghouses to control emissions of air pollutants.

A baghouse consists of one or more isolated compartments containing rows of long, cylindrical bags (or tubes) made of woven or felted fabric that filter particulates. As the particle laden air or gas enters a baghouse, it is directed into a compartment containing the bags and typically travels along the surface of the bags and ultimately through the fabric. Particles are retained on the face of the bags while the filtered air stream is drawn through the bags and then vented to the atmosphere. The baghouse is operated cyclically, alternating between relatively long periods of filtering and short periods of cleaning. During cleaning, particles that have accumulated on the surface of the bags are removed and deposited in a hopper for subsequent disposal.

Baghouses are very efficient particulate collectors because of the dust cake formed on the surface of the bags. When used in tandem with other control technology, such as a dry sorbent injection system, a baghouse can affect additional emission reduction benefits. In the case of the Carbon Plant, unreacted sodium bicarbonate caked on the bag provides another opportunity for capture and neutralization of the SO_2. The Carbon

Plant uses a pulse-jet type of baghouse. Figure 4 is a cut-away image of a pulse-jet baghouse.

Figure 4: Pulse-Jet Baghouse

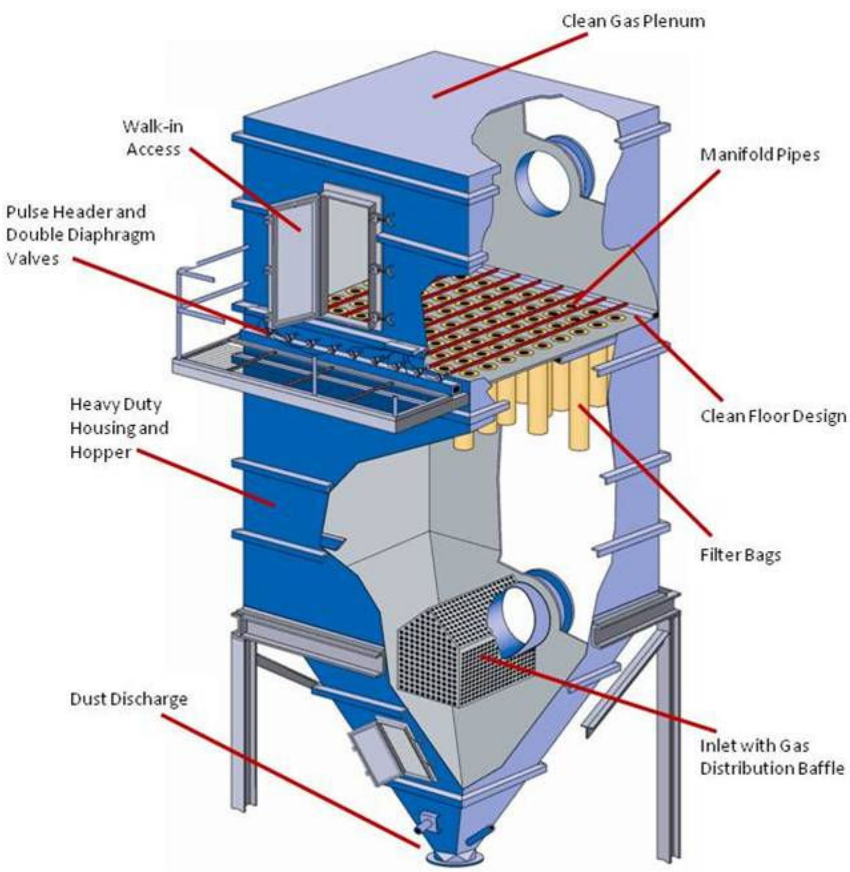

Image Source: http://www.industricorp.com/wp-content/uploads/2013/05/Jet-III-cut-a-way.jpg

III. REGULATORY PROPOSAL

Currently, the Air District does not have a specific rule that regulates SO_2 emissions from petroleum coke calcining operations. However, the facility is required to have a permit to operate.

Proposed Regulation 9, Rule 14, is a new rule. Under Rule 9-14, the Carbon Plant would be subject to two emission requirements. One requirement is an SO_2 mass emission limit while the second is a requirement for each kiln to inject dry sorbent into each kiln's exhaust flue at a minimum rate. Both emission requirements would apply to one kiln first, then the other kiln one year later in order to allow the facility to continue operations. The Carbon Plant would decide which of the two kilns they would focus on upgrading first.

A. Proposed Regulation 9, Rule 14: Petroleum Coke Calcining Operations

The draft language for the proposed rule is included in Appendix A of this report. The proposed emission limits in Regulation 9, Rule 14 would be consistent with the only current air quality regulation in California that limits SO_2 emissions from petroleum coke calcining operations. Staff has reviewed the two petroleum coke calcining rules that exist in the state – South Coast Air Quality Management District (SCAQMD) Rule 1119 and San Luis Obispo Air Pollution Control District Rule 440. Both rules require an 80 percent SO_2 emission reduction from petroleum coke calcining operations. The petroleum coke calcining plant in San Luis Obispo County is no longer in operation, but that rule's emissions limits are still in effect. The South Coast calcining facility, a Tesoro facility, is subject to an 80 percent emission reduction requirement for SO_2. The facility's control system, a semi-dry scrubber combined with a wet electrostatic precipitator, consistently reduces SO_2 emissions in excess of 95 percent to comply with Rule 1119 requirements.

Air District staff has worked with Carbon Plant representatives and other interested parties to find a method of achieving emission reductions that are effective, practical and cost effective. Based on lab test results, conversations with vendors and Carbon Plant representatives, Air District staff has concluded that the chemical reaction in the existing DSI system is not as efficient as it can be. The DSI system does not appear to reduce SO_2 emissions to the maximum extent possible. One major reason that this is the case is that the facility is not injecting enough dry sorbent material sufficient to achieve what is known as a Normalized Stoichiometric Ratio (NSR). A stoichiometric ratio for a dry sorbent injection system is the ideal mass of dry sorbent that is required to abate the entire mass of unabated SO_2 in the exhaust. The NSR for sodium bicarbonate, the dry sorbent the Carbon Plant currently uses, is to inject 2.63 pounds of sodium bicarbonate for every 1 pound of unabated SO_2. According to records the Carbon Plant has submitted to the Air District, they are currently injecting enough dry sorbent material to achieve an annual average NSR of 0.4. To approach a full NSR, the Carbon Plant will have to not only purchase significantly more sodium bicarbonate, they will also have to upgrade the sodium bicarbonate delivery system.

According to vendor estimates an NSR of approximately 1.2 would be required to achieve an 80 percent control of SO_2. An NSR of 0.9 would achieve approximately 70% control of SO_2.

<u>First Emission Requirement</u>

The only other petroleum coke calcining plant currently operating in the State of California has the ability to meet an 80 percent SO_2 emission reduction requirement.

The Air District proposes a mass emission limit of 144 lb/hr that is equivalent to an 80 percent standard. This will be determined on a daily average basis.

This rate was determined as follows:

An average SO_2 inlet concentration was calculated by averaging inlet SO_2 concentration from all of the source tests conducted at the Carbon Plant during 2014 and 2015. The inlet is the sampling location in the acid-gas exhaust stream prior to the injection of dry sorbent material to remove SO_2 from the exhaust. This sample represents the unabated concentration of SO_2. On average the inlet concentration of SO_2 is equal to 12.81 pounds of SO_2 for every ton of green coke processed by the kiln.

To account for excursions that occur from time to time and are considered part of normal operating conditions and must be handled, staff added three standard deviations of 1.8 to the average inlet concentration. If the system must be shut down in order to repair a problem, it cannot be shut down suddenly. It takes approximately three hours for that process to occur. Emissions will spike temporarily when such events occur. In order to accommodate these possible situations, the emission rate is determined on a daily average basis.

Thus, the emission factor is 12.81 lbs/ton + 5.4 lbs/ton = 18.21 lbs/ton. Multiplying the emissions rate by capacity of the kiln yields 719 lbs of SO_2 per hour. Multiplying this figure by 20 percent provides the rule's maximum hourly SO_2 emission limit.

<u>Second Emission Requirement</u>

The Carbon Plant will also be required to either meet annual SO2 mass emissions limit of 770 tpy or demonstrate that they are achieving an 80 percent control of SO_2 emissions on an annual basis.

The annual limit of 770 tpy is consistent with normal production rates and a 70 percent control of SO_2 by the Carbon Plant's DSI system. The Air District is confident that 80 percent control is technically feasible and that the cost effectiveness is reasonable. However, the Air District is concerned about the economic feasibility of meeting that limit. The 770 tpy limit balances the need for reasonable control of SO_2 with the socioeconomic impacts of the cost of controls.

The annual mass emission limit was calculated by multiplying the 12.81 lb/ton emission factor by the typical throughput of the Carbon Plant and multiplying that number by 30 percent.

If the Carbon Plant can demonstrate an 80 percent reduction in SO2, then the 770 tpy limit does not apply.

Timing of Requirements

The proposed rule requires that one kiln meet the emission requirement by January 1, 2019 and that both kilns meet the requirement by January 1, 2020. This will allow for the time needed to design and install the required improvements to the sorbent delivery system.

IV. EMISSIONS AND EMISSION REDUCTIONS

A. Emissions Inventory

Because this rule would affect only one facility, the abated SO_2 emissions inventory is based on the Carbon Plant's annual throughput information submitted to the Air District. Staff developed the average unabated rate of SO_2 emissions based on measured inlet concentrations from source tests that were conducted on both kilns during 2014 and 2015.

To develop a profile for the Carbon Plant's rate of emissions and to determine the current rate of SO_2 emission reductions from each kiln on a percentage basis, staff used abated and unabated SO_2 emissions data, green coke throughput, calcined coke production rates and sodium bicarbonate usage and averaged them over a three-year period. The most recent three-year period included 2010, 2013 and 2014 when both kilns were considered to be fully operational. The kilns operated at unusually low production levels in 2011 and 2012. The averages are representative of SO_2 emissions and emission reductions during normal operating conditions for each kiln.

Staff estimated the average SO_2 emission reductions combined from both kilns to be 42 percent. The average NSR is 0.4 and the average amount of abated SO_2 emitted from both exhaust stacks was 1,480 tons. The total mass of unabated SO_2 prior to abatement for that year was 2,550 tons. When both kilns were both fully operational for an aggregate 36 month period, the average amount of SO_2 emitted into the ambient air, after 42 percent had been removed by the system's DSI controls, was 4.0 tons per day.

B. Emission Reductions

The Air District's 2013 emissions inventory indicates the total SO_2 emissions from the calcining operation to be 3.1 tpd. This was the year the Air District selected as the base year for calculating the benefits of the Refinery Strategy. For the Carbon Plant, however, this was a year where production of calcined coke was significantly below the long-term average. As a result, the emissions in the 2013 inventory are unusually low. The three-year average for SO_2 emissions when both kilns are fully operational is 4.0 tpd. This number takes into account SO_2 emission reductions currently achieved by the DSI system.

Until recently, SO_2 abatement efficiency data were not required. Source tests had never been performed to determine SO_2 concentrations prior to acid-gas treatment. Without this information, the abatement efficiency of the DSI system was unknown. Based on recent testing data by Air District staff and additional source test information provided by the Carbon Plant, the SO_2 emission reductions from the calcining operation are better understood. The DSI system reduces approximately 37 percent of the SO_2 emissions from K-1 and approximately 47 percent of the SO_2 emissions at K-2. Together, they average an SO_2 removal efficiency of 42.1 percent.

When Regulation 9, Rule 14 is fully implemented, control efficiency will improve to either 70 or 80 percent, as a result SO_2 emissions are expected to be reduced by between 1.9 and 2.7 tpd in a typical year. Formation of $PM_{2.5}$ a secondary pollutant that forms from SO_2 in the ambient air will also be significantly reduced.

V. Economic Impacts

A. Compliance Costs and Cost Effectiveness

The Carbon Plant has stated that they are willing to spend between $4 million to $5 million to upgrade their SO_2 controls. They have annualized that capital expense to $250,000, assuming a 20-year life span of the new equipment. The majority of the annual cost is for dry sorbent purchase and delivery and for the disposal of the spent sorbent. Based on cost quotes from a sorbent supplier, the Air District estimates these costs to be $500 per ton of additional sorbent.

The rule as proposed has been structured to be cost effective. An analysis of cost effectiveness follows.

Control Costs

Cost effectiveness is the sum of costs to comply with the proposed rule on ~~a~~an annual basis divided by the expected emissions reduction on an annual basis. Cost effectiveness (C.E.) is expressed by the following equation:

C.E. = Costs / emissions reductions

Where C.E. is expressed in in dollars per ton

The estimated annual cost for the Carbon Plant to improve their current DSI system to comply with the rule's 770 tpy emission requirement is approximately from $2.0 million. This would reduce emissions by 710 tons in a typical year.

C.E. = $2,000,000 / 710 tons = $2,817 / ton SO_2 reduced

The estimated annual cost for the Carbon Plant to demonstrate 80 percent control on an annual basis is approximately from $3.0 million. This would reduce emissions by 969 tons in a typical year.

C.E. = $3,000,000 / 969 tons = $3,096 / ton SO_2 reduced

The rule is very cost effective. As a comparison, Air District organic compound control rules typically range from several thousand to over fifteen thousand dollars per ton of emissions reductions, and rules to reduce oxides of nitrogen, NOx, typically range from about seven thousand to around twenty thousand dollars per ton of emissions reduced.

B. Socioeconomic Impact Analysis

Section 40728.5 of the California Health and Safety Code requires an air district to assess the socioeconomic impacts of the adoption, amendment or repeal of a rule if the rule is one that “will significantly affect air quality or emissions limitations.” Applied Development Economics, Inc. of Walnut Creek, California has prepared a socioeconomic analysis for proposed Regulation 9, Rule 14.

The analysis concludes that the proposed rule will have a significant economic impact on the Carbon Plant and may lead to regional job loss. The proposed rule is intended to minimize socioeconomic impacts by allowing the Carbon Plant to meet a 770 tpy annual limit in lieu of achieving 80 percent control on an annual basis. The socioeconomic analysis is attached as Appendix B.

C. Incremental Cost Analysis

Health and Safety Code Section 40920.6 requires an air district to assess the incremental cost-effectiveness for a regulation that identifies more than one control option to meet the same emission reduction objectives. Incremental cost-effectiveness is defined as the difference in costs divided by the difference in emission reductions between one level of control and the next. As discussed above, the cost-effectiveness for the requirement to use control technology to comply with 770 tpy mass emission SO_2 limit in Section 301 for petroleum coke calcining operations is estimated to be $2,817 per ton of SO_2 emissions reduced. The Carbon Plant operators (Phillips 66 or P66) presented a plan to the Air District staff that would reduce emissions to a level consistent with 50 percent control on an annual basis. That would reduce emissions by 203 tpy in a typical year at a cost of $900,000 for a cost effectiveness of $4,433/ton of SO_2 reduced.

The incremental cost between two options is calculated as follows:

(Option 2 cost – Option 1 cost) / (Option 2 reductions – Option 1 reductions)

For the two options listed above the calculation is as follows:

($2.0 – $0.9 million) / (710 – 203 tons) = $1.1 million / 507 tons = $2,169/ton

So, for an additional $1.1 million/year in costs, emissions are reduced by 710 tons.

Control Option	Annualized Costs ($/yr)	Control Efficiency (%)	SO_2 Emissions Reductions (tons/yr)	Cost Effectiveness ($/ton)	Incremental Cost Effectiveness ($/ton)
P66 Optimization	$0.9 million	50%	203	$4,433	n/a
Meet Annual Mass Emission Limit	$2.0 million	70%	710	$2,817	$2,169
Meet 80% Control Requirement	$3.0 million	80%	969	$3,096	$3,861

The table above expands this analysis to the option of demonstrating 80 percent control on an ongoing basis. The table demonstrates that the incremental cost effectiveness between each of the options is reasonable. But, the incremental cost effectiveness between the P66 proposal and the mass emission limit is particularly reasonable. A great deal of additional emission control is provided for the additional $1.1 million/year investment.

VI. Environmental Impacts

Pursuant to the California Environmental Quality Act, the District has caused an initial study for proposed Regulation 8, Rule 53 to be prepared by Environmental Audits of Placentia, CA. The assessment concludes that the proposed rule would not result in significant adverse environmental impacts. A copy of the study and draft Negative Declaration is attached as Appendix C.

VII. REGULATORY IMPACTS

A. California Health and Safety Code 40727.2 Impacts

Section 40727.2 of the Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and district air pollution control requirements for the equipment or source type affected by the proposed change in district rules. The district must then note any differences between these existing requirements and the requirements imposed by the proposed change. The Carbon Plant is not subject to any specific Federal requirements, but is subject to existing Air District Rules.

Regulation	Requirement
BAAQMD 6-1-301	Opacity limit, Ringelmann 1
BAAQMD 6-1-310	Particulate limit, 0.15 grain/cubic foot
BAAQMD 6-1-311	Process weight based particulate matter limit
BAAQMD 9-1-301	Maximum ground level SO_2 concentration not to exceed
BAAQMD 9-1-310.2	SO_2 limit of 400 parts per million (ppm) or 113 kilograms/hour (247 lb/hr), whichever is more restrictive

Adoption of Regulation 9, Rule 14, would not conflict with any existing federal or District requirement. It would be more restrictive than the current 247 lb/hr limit for each kiln.

B. Senate Bill 288 Conformity

Senate Bill (SB) 288, later codified in the California Health and Safety Code commencing at §42500, prohibits air districts from making changes to their new source review rules that would make the rule less stringent than it was on December 30, 2002, unless certain conditions were met. The proposed rule conforms with this requirement.

VIII. RULE DEVELOPMENT PROCESS

Air District staff from the Planning, Legal, Technical, Engineering, and Compliance and Enforcement Divisions developed Regulation 9, Rule 14 through a rule development process that began in September of 2012. Staff has engaged in in a comprehensive and rule development process involving many discussions with representatives from the Carbon Plant, several visits to the facility, and conducted multiple source tests of the facility's calcining SO_2 control equipment.

The following meetings and efforts to work with the interested public and affected industry to solicit comments on the draft rule proposal, then took place:

- Sept. 2015: Open House in Martinez (Martinez Junior High)
- Sept. 2015: Open House in Richmond (Lincoln Elementary School)
- Sept. 2015: Open House in Benicia (Robert Semple Elementary School)

At the open house meetings, staff met with representative from industry, residents from local neighborhoods, and other interested parties.

Staff reviewed and considered all comments received at the public workshops and subsequent to workshops and made revisions to the proposal as appropriate. Staff continued discussions with Carbon Plant representatives and other regulatory agencies and again met with them on October 15, 2015, to discuss SO_2 emission reduction for the draft rule. We were not able to come to an agreement. Carbon Plant representatives offered to submit a counter to the requirements in the draft rule within 24 hours; however, staff did not receive such information as of October 19, 2015.

IX. CONCLUSIONS

Pursuant to Section 40727 of the California Health and Safety Code, the proposed rule amendments must meet findings of necessity, authority, clarity, consistency, non-duplication, and reference before the Board of Directors adopt, amend, or repeal a rule. The proposed Rule is:

- Necessary to protect public health by reducing ozone precursors to meet the commitment of Control Measure SSM5 of the Bay Area 2010 Clean Air Plan;
- Authorized by California Health and Safety Code Sections 40000, 40001, 40702, and 40725 through 40728;
- Clear, in that the rule specifically delineates the affected industry, compliance options, and administrative requirements for industry subject to this rule, so that its meaning can be easily understood by the persons directly affected by it;
- Consistent with other California air district rules, and not in conflict with state or federal law:
  - Non-duplicative of other statutes, rules, or regulations; and,
  - Implementing, interpreting and making specific and the provisions of the California Health and Safety sections 40000 and 40702.

A socioeconomic analysis prepared by Bay Area Economics has found that the proposed amendments would have a significant economic impact and may lead to regional job loss. District staff have reviewed and accepted this analysis. A California Environmental Quality Act analysis prepared by Environmental Audit, Inc., concludes that the proposed amendments would not result in significant adverse environmental impacts. District staff have reviewed and accepted this analysis as well.

X. REFERENCES

[1] Bay Area Air Quality Management District Emissions Inventory.
[2] South Coast AQMD, Rule 1119.
[3] Bay Area Air Quality Management District; "SSM 8 – Petroleum Coke Calcining Operations, Bay Area 2010 Clean Air Plan," Volume 2; September 2010.
[4] ADE Socioeconomic Analysis for BAAQMD Proposed Regulation 9, Rule 14.
[5] Multiple conversations with Carbon Plant representatives.
[6] http://www.piaj.gr.jp/roller/en/entry/200706118.
[7] http://www.epa.gov/airquality/sulfurdioxide/health.html.
[8] Babcock & Wilcox Technical Paper (September 2010), Pollution Control Technology for the Cement Industry.
[9] EPA Pollution Control Technology Fact Sheet, EPA-452/F-03-034.
[10] www.babcock.com/library/Documents/PS-451.pdf.
[11] Multiple consultations with SO_2 control equipment vendors Babcock & Wilcox, and, Envitech, October 2012